WHAT IS CLAIMED IS:

1. A plane diffraction grating with grooves formed on a surface thereof, the plane diffraction grating being rotated about a rotational axis which is normal to the surface, and being characterized in that a profile of the grooves at a radial area is determined depending on a rotational position of the area about a rotational center defined as a foot of the rotational axis on the surface of the plane diffraction grating.

Sub A1

2. The plane diffraction grating according to claim 1, wherein the plane diffraction grating is a blazed type, and a blaze angle $\theta_0$ of the grooves in an area along an original line at the rotational position $\phi = 0$ is set as:

$$\theta_0 = \frac{\alpha + \beta}{2},$$

where $\alpha$ is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and $\beta$ is an angle of a diffraction ray from the normal, and a blaze angle $\theta_\phi$ of the grooves in an area along a line at the rotational position $\phi$ is set as

$$\sin\theta_\phi = \sin\theta_0 \sqrt{\frac{1+\tan^2\phi}{1+\tan^2\phi\sin^2\theta_0}}.$$

3. The plane diffraction grating according to claim 2, wherein:

the surface of the plane diffraction grating is covered with a multiple-layer coating to improve reflectivity;

an unit thickness $d_{b0}$ of the multiple-layer coating in the area along the original line at the rotational position $\phi = 0$ satisfies the equation:

$$m_b\lambda_0 = 2d_{b0}R_{\alpha 0}\cos(\alpha-\theta_0),$$

where

$m_b$ is the diffraction order,

$\lambda_0$ is the wavelength of the light diffracted by the area,

$R_{\alpha 0} = \sqrt{1-(2\delta-\delta^2)/\cos^2\alpha}$,

$\delta = 1 - n$,

$n$ is the average refractive index of the multiple-layer coating,

and an unit thickness $d_{b\phi}$ of the multiple-layer coating in the area along the line at the rotational position $\phi$ satisfies the equation

$$m_b\lambda = 2d_{b\phi}R_{\alpha\phi}\cos(\alpha-\theta_0),$$

where

$\lambda$ is the wavelength of the light diffracted by the area

$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi-\delta^2_\phi)/\cos^2\alpha}$,

$\delta_\phi = 1 - n_\phi$,

$n_\phi$ is the average refractive index of the multiple-layer coating.

4. The plane diffraction grating according to claim 1, wherein the plane diffraction grating is a laminar type, and a depth $h_0$ of the grooves in an area along an original line at the rotational position $\phi = 0$ is set as

$$h_0 = \frac{\lambda_0}{2(\cos\alpha + \cos\beta)},$$

where $\lambda_0$ is the wavelength of the light diffracted by the area, $\alpha$ is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and $\beta$ is an angle of a diffraction ray from the normal, and

a depth $h_\phi$ of the grooves in an area along a line at the rotational position $\phi$ is set as

$$h_\phi = \frac{\lambda_0}{2(\cos\alpha + \cos\beta)\cos\phi}.$$

5. The plane diffraction grating according to claim 4, wherein:

the surface of the plane diffraction grating is covered with a multiple-layer coating to improve reflectivity;

an unit thickness $d_{b0}$ of the multiple-layer coating in the area along the original line at the rotational position $\phi = 0$ satisfies the equation:

$$m_b\lambda_0 = d_{b0}(R_{\alpha0}\sin\alpha + R_{\beta0}\sin\beta),$$

where

$m_b$ is the diffraction order,

$R_{\alpha0} = \sqrt{1-(2\delta-\delta^2)/\cos^2\alpha}$, $R_{\beta0} = \sqrt{1-(2\delta-\delta^2)/\cos^2\beta}$;

$\delta = 1 - n$,

$n$ is the average refractive index of the multiple-layer coating,

and

an unit thickness $d_{b\phi}$ of the multiple-layer coating in the area along the line at the rotational position $\phi$ satisfies the equation:

$$m_b\lambda = d_{b\phi}(R_{\alpha\phi}\sin\alpha + R_{\beta\phi}\sin\beta),$$

where

$\lambda$ is the wavelength of the light diffracted by the area

$$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi - \delta_\phi^2)/\cos^2\alpha}, \quad R_{\beta\phi} = \sqrt{1-(2\delta_\phi - \delta_\phi^2)/\cos^2\beta},$$

$\delta_\phi = 1 - n_\phi$,

$n_\phi$ is the average refractive index of the multiple-layer coating.

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6. An optical system comprising:

a plane diffraction grating having grooves on a surface of the plane diffraction grating whose profile at an area is determined depending on a rotational position of the area about a rotational center defined as a foot of the rotational axis defined below;

a mechanism for rotating the plane diffraction grating about a rotational axis which is normal to the surface;

an incidence optical system for casting a converging beam of light on a point of the surface of the plane diffraction grating, the point being apart from the rotational center.

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7. The optical system according to claim 6, wherein the plane diffraction grating is a blazed type, and a blaze angle $\theta_0$ of the grooves in an area along an original line at the rotational position $\phi = 0$ is set as:

$$\theta_0 = \frac{\alpha + \beta}{2},$$

where $\alpha$ is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and $\beta$ is an angle of a diffraction ray from the normal, and

a blaze angle $\theta_\phi$ of the grooves in an area along a line at the rotational position $\phi$ is set as:

$$\sin\theta_\phi = \sin\theta_0 \sqrt{\frac{1+\tan^2\phi}{1+\tan^2\phi\sin^2\theta_0}}.$$

8. The optical system according to claim 7, wherein:

the surface of the plane diffraction grating is covered with a multiple-layer coating to improve reflectivity;

an unit thickness $d_{b0}$ of the multiple-layer coating in the area along the original line at the rotational position $\phi = 0$ satisfies the equation:

$$m_b\lambda_0 = 2d_{b0}R_{\alpha 0}\cos(\alpha - \theta_0),$$

where

$m_b$ is the diffraction order,

$\lambda_0$ is the wavelength of the light diffracted by the area,

$R_{\alpha 0} = \sqrt{1-(2\delta - \delta^2)/\cos^2\alpha}$,

$\delta = 1 - n$,

$n$ is the average refractive index of the multiple-layer coating,

and

an unit thickness $d_{b\phi}$ of the multiple-layer coating in the area along the line at the rotational position $\phi$ satisfies the equation:

$$m_b\lambda = 2d_{b\phi}R_{\alpha\phi}\cos(\alpha - \theta_0),$$

where

$\lambda$ is the wavelength of the light diffracted by the area

$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi - \delta^2{}_\phi)/\cos^2\alpha}$,

$\delta_\phi = 1 - n_\phi$,

$n_\phi$ is the average refractive index of the multiple-layer coating.

9. The optical system according to claim 6, wherein the plane diffraction grating is a laminar type, and a depth $h_0$ of the grooves in an area along an original line at the rotational position $\phi = 0$ is set as

$$h_0 = \frac{\lambda_0}{2(\cos\alpha + \cos\beta)},$$

where $\lambda_0$ is the wavelength of the light diffracted by the area, $\alpha$ is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and $\beta$ is an angle of a diffraction ray from the normal, and

a depth $h_\phi$ of the grooves in an area along a line at the rotational position $\phi$ is set as

$$h_\phi = \frac{\lambda_0}{2(\cos\alpha + \cos\beta)\cos\phi}.$$

10. The optical system according to claim 9, wherein:

the surface of the plane diffraction grating is covered with a multiple-layer coating to improve reflectivity;

an unit thickness $d_{b0}$ of the multiple-layer coating in the area along the original line at the rotational position $\phi = 0$ satisfies the equation:

$$m_b\lambda_0 = d_{b0}(R_{\alpha 0}\sin\alpha + R_{\beta 0}\sin\beta),$$

where

$m_b$ is the diffraction order,

$$R_{\alpha 0}=\sqrt{1-(2\delta-\delta^2)/\cos^2\alpha}\,,\quad R_{\beta 0}=\sqrt{1-(2\delta-\delta^2)/\cos^2\beta}\,,$$

$\delta=1-n,$

$n$ is the average refractive index of the multiple-layer coating,

and

an unit thickness $d_{h\phi}$ of the multiple-layer coating in the area along the line at the rotational position $\phi$ satisfies the equation:

$$m_h\lambda=d_{h\phi}(R_{\alpha\phi}\sin\alpha+R_{\beta\phi}\sin\beta)\,,$$

where

$\lambda$ is the wavelength of the light diffracted by the area,

$$R_{\alpha\phi}=\sqrt{1-(2\delta_\phi-\delta^2_\phi)/\cos^2\alpha}\,,\quad R_{\beta\phi}=\sqrt{1-(2\delta_\phi-\delta_\phi^2)/\cos^2\beta}\,,$$

$\delta_\phi=1-n_\phi,$

$n_\phi$ is the average refractive index of the multiple-layer coating.

Sub A3

11. A method of producing a plane diffraction grating having grooves on a surface thereof whose profile at an area is determined depending on a rotational position of the area about a rotational center, the method comprising the steps of:

coating a substrate with a photo-resist layer and forming a photo-resist mask from the photo-resist layer according to a preset pattern of groove arrangement;

covering the photo-resist mask with a sector mask having an opening of a narrow sector whose apex is set at the rotational center;

etching the substrate over the sector mask with an appropriate etching condition depending on a rotational position of the sector mask about the rotational center;

rotating the sector mask by an angle of the apex of the narrow sector; and

repeating the etching process and the mask rotating process until the narrow sector sweeps the surface of the substrate.

12. The plane diffraction grating producing method according to claim 11, wherein the plane diffraction grating is a blazed type, and the etching condition in the etching process is such that:

a blaze angle $\theta_0$ of the grooves in an area along an original line at the rotational position $\phi = 0$ is set as

$$\theta_0 = \frac{\alpha + \beta}{2},$$

where $\alpha$ is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and $\beta$ is an angle of a diffraction ray from the normal, and

a blaze angle $\theta_\phi$ of the grooves in an area along a line at the rotational position $\phi$ is set as

$$\sin\theta_\phi = \sin\theta_0 \sqrt{\frac{1+\tan^2\phi}{1+\tan^2\phi\sin^2\theta_0}}.$$

13. The plane diffraction grating producing method according to claim 12, wherein the surface of the plane diffraction grating is then covered with a multiple-layer coating to improve reflectivity, and:

an unit thickness $d_{b0}$ of the multiple-layer coating in the area along the original line at the rotational position $\phi = 0$ satisfies the equation:

$$m_b\lambda_0 = 2d_{b0}R_{\alpha 0}\cos(\alpha - \theta_0),$$

where

$m_b$ is the diffraction order,

$\lambda_0$ is the wavelength of the light diffracted by the area,

$R_{\alpha 0} = \sqrt{1-(2\delta - \delta^2)/\cos^2\alpha}$,

$\delta = 1 - n$,

$n$ is the average refractive index of the multiple-layer coating,

and

an unit thickness $d_{b\phi}$ of the multiple-layer coating in the area along the line at the rotational position $\phi$ satisfies the equation:

$$m_b \lambda = 2 d_{b\phi} R_{\alpha\phi} \cos(\alpha - \theta_0),$$

where

$\lambda$ is the wavelength of the light diffracted by the area

$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi - \delta^2_\phi)/\cos^2\alpha}$,

$\delta_\phi = 1 - n_\phi$,

$n_\phi$ is the average refractive index of the multiple-layer coating.

14. The plane diffraction grating producing method according to claim 11, wherein the plane diffraction grating is a laminar type, and the etching condition in the etching process is such that:

a depth $h_0$ of the grooves in an area along an original line at the rotational position $\phi = 0$ is set as

$$h_0 = \frac{\lambda_0}{2(\cos\alpha + \cos\beta)},$$

where $\lambda_0$ is the wavelength of the light diffracted by the area, $\alpha$ is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and $\beta$ is an angle of a diffraction ray from the normal, and

a depth $h_\phi$ of the grooves in an area along a line at the rotational position $\phi$ is set as

$$h_\phi = \frac{\lambda_0}{2(\cos\alpha + \cos\beta)\cos\phi}.$$

15. The plane diffraction grating producing method according to claim 4, wherein the surface of the plane diffraction grating is then covered with a multiple-layer coating to improve reflectivity, and:

an unit thickness $d_{b0}$ of the multiple-layer coating in the area along the original line at the rotational position $\phi = 0$ satisfies the equation

$$m_b\lambda_0 = d_{b0}(R_{\alpha 0}\sin\alpha + R_{\beta 0}\sin\beta),$$

where

$m_b$ is the diffraction order,

$$R_{\alpha 0} = \sqrt{1-(2\delta-\delta^2)/\cos^2\alpha}, \quad R_{\beta 0} = \sqrt{1-(2\delta-\delta^2)/\cos^2\beta},$$

$$\delta = 1 - n,$$

where $n$ is the average refractive index of the multiple-layer coating,

and

an unit thickness $d_{b\phi}$ of the multiple-layer coating in the area along the line at the rotational position $\phi$ satisfies the equation

$$m_b\lambda_0 = d_{b\phi}(R_{\alpha\phi}\sin\alpha + R_{\beta\phi}\sin\beta),$$

where

$\lambda$ is the wavelength of the light diffracted by the area

$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi - \delta^2_\phi)/\cos^2\alpha}$ ,  $R_{\beta\phi} = \sqrt{1-(2\delta_\phi - \delta^2_\phi)/\cos^2\beta}$ ,

where $\delta_\phi = 1 - n_\phi$ and

$n_\phi$ is the average refractive index of the multiple-layer coating.